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Supplying the Retail Market

The great joy of being associated with the foundry industry is the widespread knowledge of other industries to be found amongst its leaders. At the one extreme, the country jobbing foundry owner knows nearly as much about district farming as the local innkeeper, whilst the large textile machinery makers have to know as much about the industry they serve as their customers. This is what makes a gathering of foundrymen so interesting. We are not so satisfied that the industry is equally so knowledgeable when its customer is the man-in-the-street. Only last week, we were shown a line of mincing machines, which was an excellent engineering job, and commendable in every way except in one instance—it was ugly. We hold no brief for those firms which err on the other side and sell an artistic article which is not an engineering job. The two can and must be combined. Moreover, the combination is not necessarily dearer to manufacture, whilst it should be cheaper to sell. Unfortunately, or in truth, fortunately, the whole world has not the same artistic appreciation, and this must be taken into consideration when thinking around exports.

A recent acquisition for home use is an electric iron, which is both artistic and utilitarian. It would sell anywhere in the world in the high-class stores. For the market which must use the old-fashioned flat iron, owing to the absence of electricity or gas, the inclusion of a recessed hole to contain a recessed pyrometer of the " Sentinel " type to indicate correct heat, or a coat of vitreous enamel, would aid sales. Too much attention cannot be given to the question of colour and the introduction of gadgets when catering for the retail market. It pays, nowadays, even with the simplest of articles, to provide an instruction card for care and maintenance, as its wording can be so oriented to enhance interest in a newly acquired article. Even a bath tub installed in a " pre-fab " could usefully carry a tag explaining that it is made of " glass on metal," and needs intelligent handling in use if it is to retain its good appearance over the years.

The care of lawn mowers is a similar case where the buyer can be given the impression that the maker retains his interest in the article after sale. The lawn-mower makers could usefully follow the lead of the gas-cooker manufacturers, who provide the housewife with an excellent cookery book, by giving their customers a booklet on " The Care of the Lawn." It might help to sell a roller also! The main factor to remember is that the retail shopkeeper appreciates to the full any recognition the manufacturers can show of his perception of what pleases the ultimate buyers. It largely relieves him of the responsibility of giving advice which may or may not turn out satisfactorily.

PRICE OF LINSEED OIL INCREASED

A rise in the price of linseed oil by £70 a ton, for the four-week period ending September 28, has been announced by the Ministry of Food. It is believed that the bulk purchase of considerable quantities of linseed oil from the Argentine, by the Ministry, is responsible for the increase.

The sharp rise in price, now to be borne by manufacturers, will, in consequence, be reflected in their prices. The need for foundrymen to economise is stressed, now, more than ever.

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BORE CRACKS

Causes and methods of prevention of bore cracks which are hot tears that occur in the bores of valves and fittings under the flanges, were set out in a Paper to the A.F.A. annual meeting, earlier this year, entitled "Bore Cracks in Cast Steel Fittings and Valve Bodies," by H. F. Taylor, research associate, M.I.T., and H. F. Bishop and W. H. Johnson, of the Naval Research Laboratory of the Office of Research and Inventions, Washington, U.S.A. The Authors of the Paper pointed out that these cracks are caused by stresses which result when the ends of a valve or fitting and the comparatively thin barrel contract circumferentially and pinch down on the core, thus restraining linear contraction from taking place. Bleeding tests show that the bore crack occurs after the barrel has solidified, at which time the stresses due to linear contraction exceed the strength of the metal skin beneath the flange.

This defect can be eliminated, the Authors claimed, by two means: (*a*) By the use of a hollow core, which can be deformed by the circumferential contraction of the casting, automatically relieving the stresses and permitting linear contraction to take place; and (*b*) by the use of graphite collars or properly designed steel chills in the core which chill and strengthen the metal in the casting so that its strength exceeds the imposed stress. The influence of other factors, some of which have a minor effect on the bore crack, were also studied. These include gating and risering practice, mould resistance, pouring temperatures, metal composition, and mould atmosphere. Theories of the cause and formation of veins, which are closely allied to the bore crack, were also covered in the Paper.

F. J. COOK AWARD

In the presidential address to the Institute of British Foundrymen annual conference, at Birmingham, in June, Mr. D. Howard Wood announced his intention of providing a sum of money which the Council of the Institute could offer as prizes in a competition for suggestions for improving foundry conditions and amenities. The Council have formally accepted Mr. Wood's generous offer, and at the same time announced the conditions governing the competition. These are as follow:

(1) The award will be made for the most practical suggestion or suggestions for improving foundry conditions and amenities. (2) All grades of members of the Institute are eligible for entry into the competition; non-members are not eligible. (3) Each entry should be in the form of a written description which may be illustrated by any means which the entrant may choose. (4) All entries are to be received by the Secretary by January 31, 1947, and to be marked in the top left-hand corner "F. J. Cook Award." (5) The wording of an entry or the way in which an entry is presented will not necessarily be taken into account, but rather the practical value of the suggestion. (6) The entries will be judged by three referees to be appointed by the Council. The decision of the referees will be final. (7) The Council reserve the right to award prizes of lesser value if in the opinion of the referees the entries to the competition are of insufficient merit. If the sum of £150 which Mr. Wood has made available for these prizes is not expended on the prizes the donor and Council shall agree a purpose on which the balance may be expended.

C.F.A. ACTIVITIES

Mr. T. E. Parkinson, secretary of the Council of Ironfoundry Associations, has just returned from a business tour of foundries and associations in Scotland and the North of England, extending over a fortnight. This is in pursuance of the policy of the C.F.A. which seeks to keep the regions fully informed of happenings at headquarters and the progress of Association work generally. Mr. Parkinson has already spent some time with the Midland associations, and on this occasion he has toured foundries in the north, and addressed meetings of the Manchester Ironfounders' Association, the I.N.C. Scottish Association, the British Ironfounders' Association, the Scottish Ironfounders' Association and the North of England Ironfounders' Association.

In an hour's address on C.F.A. activities he was able to outline briefly a number of the more important aspects of the co-ordinated work being carried out for the ironfoundry industry, and what is more important, to give to members details of the inner history of negotiations leading up to important decisions. Such information can never be adequately described in bulletins and on paper, and usually makes very interesting hearing. He was able to bring his listeners up to date on much unpublished matter, and in turn he received valuable details of regional difficulties experienced by the different organisations.

All associations concerned have expressed their appreciation of these visits and it is hoped that they may continue to derive benefit from them. To quote Mr. Parkinson's final remarks at these meetings, "Mutual co-operation among ironfounders to-day is essential and it is only by constant support of the local associations that this becomes possible. The C.F.A. is a very heterogeneous body, but therein lies its solidarity and strength. It is a source of wonder to many Government officials, and industry generally, that such a mixed body should be able to secure and hold such a measure of unanimity nationally. It is, however, only by the use to which this organisation is put by its constituents that its real value can be assessed, and it is incumbent on all member firms to use their local associations to the fullest extent. It is unfair to expect more out of the 'pint pot' than is put into it, and the greater use made of the organisation locally, the greater the services which will continue to be rendered from the headquarters of the C.F.A."

HEAT-TREATMENT OF GREY CAST IRON FOR RELIEF OF INTERNAL STRESSES*

By P. A. RUSSELL, B.Sc.†

Summary

The Author describes a series of experiments devised to ascertain the amount of relief of internal stress by heat-treatment in the range 400 to 600 deg. C., and at the same time to study the effect on the physical properties. The irons studied were all high-duty cast irons. The effects of exposing specimens to atmospheric weathering and to prior machining were also investigated. A test-piece having internal stresses caused by irregular sections was used, and the amount of stress estimated by movement of a gap cut in the heavy section.

It is shown that time, weathering and machining all have some effect on relief of internal stress, but that really substantial relief can only be obtained by heat-treatment. Further, heat-treatment only begins to be effective above 450 deg. C., and substantial relief is only obtained by temperatures above 525 deg. C., which is now the normal high limit for such treatment. The physical tests show practically no falling off of properties up to 600 deg. C.

The Author therefore recommends that for high-duty irons with a pearlitic matrix, stress-relief treatment should be carried out, after rough machining, by slow heating to 585 ± 15 deg. C., maintaining at temperature long enough for the whole furnace charge to be heated throughout, followed by slow cooling to not more than 300 deg. C., preferably 100 deg. C. One set of experiments shows that acicular, or partly acicular, structured irons require special consideration. It is pointed out that these conclusions only apply to fully pearlitic high-duty irons, and further experimental work is necessary before they can be extended to cover lower grades of grey cast iron.

Previous Work

It has long been recognised that complicated castings contain internal stress, often of a very large order, and that if such castings are finish-machined soon after pouring, there is a grave risk that the component will distort and become out of alignment. It has therefore been the practice in many machine shops to rough-machine important castings, and then store them out of doors for at least three months before finishing them. It is generally agreed that this practice reduces the risk of ultimate distortion. This system is, however, to say the least, uncertain in its results and expensive in capital outlay for storage space and stock of castings. A means of releasing stresses by heat-treatment has therefore been sought as a more controlled method of achieving the same effect and at the same time speeding up the flow of castings through the machine shops.

What is normally called "stress-relief annealing" has been carried out for at least 25 years, and it is on record[2] that one American firm has been treating large castings, up to 30 ft. long and weighing 60 to 70 tons, since 1920, using a temperature of 525 deg. C. Also the French Admiralty specification[1] calls for treatment of important castings at temperatures between 500 and 625 deg. C., followed by very slow cooling. A certain amount of research work has been carried out on the subject, and four authors[1 2 3 4] have published the results of their investigations. Their results are summarised in Fig. 1.

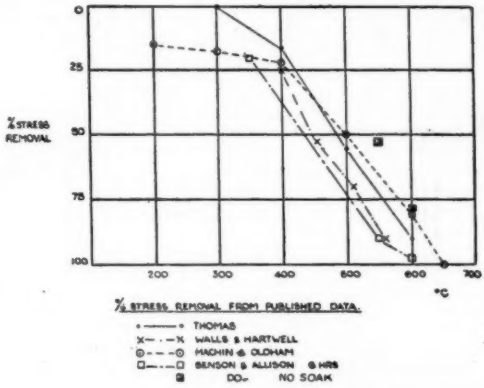

FIG. 1.—PERCENTAGE STRESS REMOVAL FROM PUBLISHED DATA.

The most important contributions to the subject in this country have been the Papers presented by Machin and Oldham[3] and Benson and Allison.[4] The former showed that casting stresses in grey iron could be almost completely relieved by heating to 650 deg. C., followed by slow cooling. Benson and Allison gave the temperature as 600 deg. C. with six hours' soak, but they pointed out that growth commences at 550 deg. C. and becomes serious at 600 deg. C. In consequence of this there was a reaction against using such high temperatures, and in some cases[7] it was recommended that 400 deg. C. should be used, with the statement that pearlite commences to decompose at 450 deg. C., and that it was important that 500 deg. C. should not be exceeded.

The present-day practice is, normally, to recommend slow heating to 475 to 500 deg. C. (with 525 deg. C. as a top limit), maintaining at temperature

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* A Paper read before the annual conference of the Institute of British Foundrymen, at Birmingham.

† Technical director, S. Russell & Sons, Limited, Leicester.

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for one hour for each inch of section, followed by cooling in the closed furnace till 300 deg. C. is reached, and, if possible, continuing this till 100 deg. C. is reached.

Need for Investigation

During the war considerable stimulus was given to stress-relieving heat-treatment by the necessity for quick turnover of castings and for very fine limits of accuracy in the finished products. The works with which the Author is connected was called upon to carry out a considerable amount of this heat-treatment on high-duty cast irons, and he was able to check up on the results obtained by use of the normal treatment outlined above.

No movement, measurable by micrometer, was observed in simple cover castings up to 3 ft. dia. of the shape shown in Fig. 2. Castings of the type shown in Fig. 3, which is the finished product, were heat-treated in the same way after rough-machining. It would be expected that such a design would open out

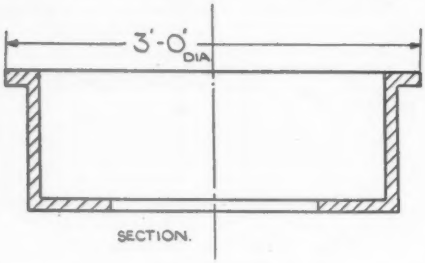

FIG. 2.—COUPLING COVER SHOWING NO CHANGE IN DIMENSIONS AFTER HEAT-TREATMENT AT 500 DEG. C.

FIG. 3.—CASTING WHICH AFTER HEAT-TREATMENT AT 500 DEG. C. SHOWED NO DIMENSIONAL CHANGE.

TABLES I TO IV.—*Stress Relief Test Results.*

All tests on bars cast 0.875 dia. Impact—ft.-lbs. on 0.798 bar, by recommended procedure. All heat-treatments 1 hr. at temperature followed by cooling in furnace. Gap increases in 0.001 in. Time elapsed between casting and final measurement, approx. six months.

TABLE I.—*Analysis.—T.C,* 3.12; *Si,* 1.93; *Mn,* 0.73; *S,* 0.129; *and P,* 0.831 per cent.
Process.—Normal Cupola Melt.

Treatment.	Tensile.	T.R.S.	Defln.	B.H.N.	Impact.	Gap increase.			Percentage stress relief.
						1.	2.	Av.	
"As-cast"	19.14	31.9	0·120	255	10.1	25	—	25	
Weathered						20	15	17.5	30
400 deg. C.		34.0	0.124			19	19	19	24
450		32.9	0.124			14	16	15	40
475		31.9	0.119			16	17	16.5	34
500	17.67	29.8	0.113			17	17	17	32
525		31.5	0.122			8	9	8.5	66
550		30.6	0.114			6	9	7.5	70
600	18.53	31.6	0.121	248	10.8	3	—	3	88

on the open face, but again micrometer measurements showed very little movement. The Author therefore felt that the temperature used was inadequate, but was prevented from raising it by the uncertainty as to whether or not the physical properties of the irons would suffer if he did so.

A series of experiments on five grades of high-duty cast iron were therefore put in hand to investigate the amount of stress relief obtained at temperatures between 400 and 600 deg. C. The actual temperatures used were 400, 450, 475, 500, 525, 550 and 600 deg. C. in anticipation that a critical range would be found between 500 and 550 deg. C. Simultaneously, test-bars for the ordinary physical tests were cast and heat-treated. A further set of tests was carried out on specimens in the same materials exposed for four months to weathering on the firm's air-raid spotting tower so that they should be subjected to the maximum changes of temperature.

The form of test-piece used is shown in Figs. 4 and 5. The thick member of this test-piece is in tension, and when a gap was milled in it where shown, this opened out about 0.020 in. (in the untreated specimens), and this gap opening has been taken as the measure of the internal stress remaining in the various specimens. The results obtained on four of the irons are set out in Tables I to IV. The results on the fifth set are discussed later.

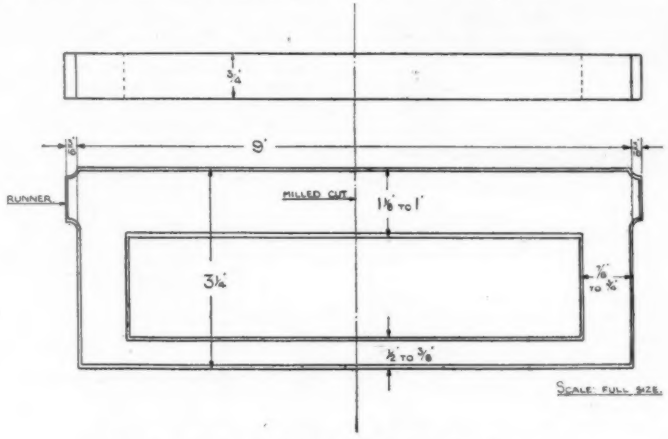

FIG. 4.—TYPE OF STRESS TEST-PIECE USED BY THE AUTHOR.

Effect of Time at Normal Temperatures

Owing to pressure of normal work this investigation proceeded very slowly, with the result that some six months elapsed between casting and final measuring. In order to check that the width of the milling

TABLE II.—*Analysis.—T.C.*, 3.15; *Si*, 1.73; *Mn*, 0.65; *S*, 0.135; *and P*, 0.37 *per cent.*
Process.—Cupola Melt, Inoculated.

Treatment.	Tensile.	T.R.S	Defln.	B.H.N.	Impact.	Gap increase.			Percentage stress relief.
						1.	2.	Av.	
"As-cast"	20.98	39.2	0.150	255	16.2	16	—	16	
Weathered						20	20	20	−25
400 deg. C.	20.22	36.8	0.147			18	20	19	−19
450		34.5	0.137			14	15	14.5	9
475		34.6	0.135			11	9	10	33
500	21.12	34.4	0.136			12	11	11.5	28
525		35.7	0.137			9	10	9.5	40
550		36.7	0.145			7	7	7	56
600	22.03	33.2	0.125	255	17.0	3	4	3.5	78

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cutter had not altered during the cutting of the test-pieces, the cut was not carried right through and a small triangular piece was left as a tie, which was sawn through after the width of the cut had been

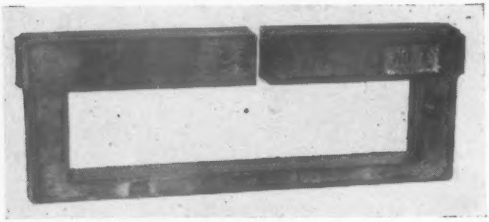

FIG. 5.—SHOWS THE APPEARANCE OF THE TEST-PIECE DETAILED IN FIG. 4.

checked. It was found that in the two months between the cutting of the specimens and measuring, the gap was approximately 0.003 in. wider than the cutter in all cases, indicating that the stress had stretched the tie. The "as-cast" and "weathered" specimens were measured almost immediately after cutting and showed no such stretch.

It is a fair assumption from this that time alone is sufficient to remove a proportion of the internal stress, and the amount removed in six months would appear to be about 15 per cent. on these particular specimens. This effect rather detracts from the exactness of the figures given in the tables, and has had to be neglected, thus giving low figures for per-

FIG. 6.—GAP INCREASES SERIES 1 TO 4.

centage stress removal, as the gap measurement is the difference observed after the tie had stretched.

Discussion of Results—Series 1-4

Certain variations occur in the figures which indicate the amount of original stress in any one set of test-pieces is not always constant, although each set was cast from one ladle of metal (casting temperature may have some effect), and every effort was made throughout the experiments to keep the conditions constant. The gap increases for each series are plotted in Fig. 6 and the percentage of stress relief obtained (on six months old specimens) is plotted as an average on the four series in Fig. 7.

From these it is reasonable to draw the following conclusions, for the range of high-duty irons studied:—(1) Exposure for four months to varying atmospheric conditions and temperatures reduces

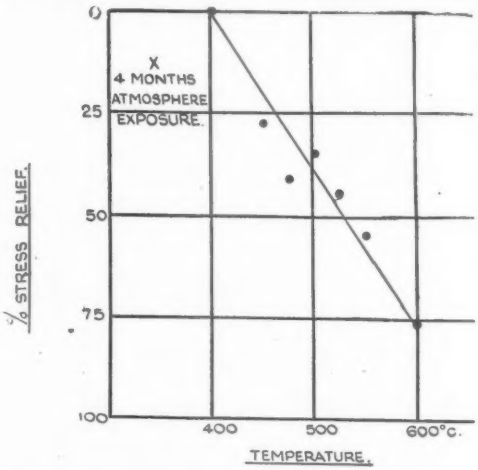

FIG. 7.—AMOUNT OF STRESS RELIEF OBTAINED ON 6 MONTHS OLD SPECIMENS. AVERAGE OF 4 HIGH DUTY CAST IRONS.

internal stresses by about 15 per cent.; (2) treatment at 400 deg. C. is quite ineffective; (3) temperatures in excess of 525 deg. C. are required to relieve 50 per cent. of the internal stress; (4) internal stresses are not completely relieved at 600 deg. C.; (5) the physical properties of the irons are not impaired by treatment up to 600 deg. C., except that some falling off in transverse strength was observed in some cases, but this was almost within the normal wide limits common to this test.

Effect of Time at Temperature

A similar series was cast in iron approximately the same as that used for series 1 and pairs of test-pieces were treated at 500 deg. C. for 2 hrs., 4 hrs.

and 6 hrs. The amount of stress relief was practically constant at about 33 per cent. From this it may be concluded that time at temperature is immaterial. This is contrary to the findings of Benson and Allison. It is, of course, important that sufficient time be allowed at the temperature for the whole of the furnace charge to reach the temperature throughout all sections.

Effect of Machining

A further series of tests was made in cupola-melted inoculated iron (T.C, 3.31; Si, 2.24; Mn, 0.76; S, 0.099, and P, 0.434 per cent.), and half of the set were machined on the two flat faces. Pairs of castings, both machined and unmachined, were subjected to different treatments and the results are shown in Fig. 8. A different system of measuring was employed for these in an attempt to get more accurate and consistent measurement. The end facings, after treatment, were machined and the residual stress expressed as the increase in length over these facings after cutting through the heavy bar. The results were more consistent than those obtained by the gap-measurement method, but were of a lower order.

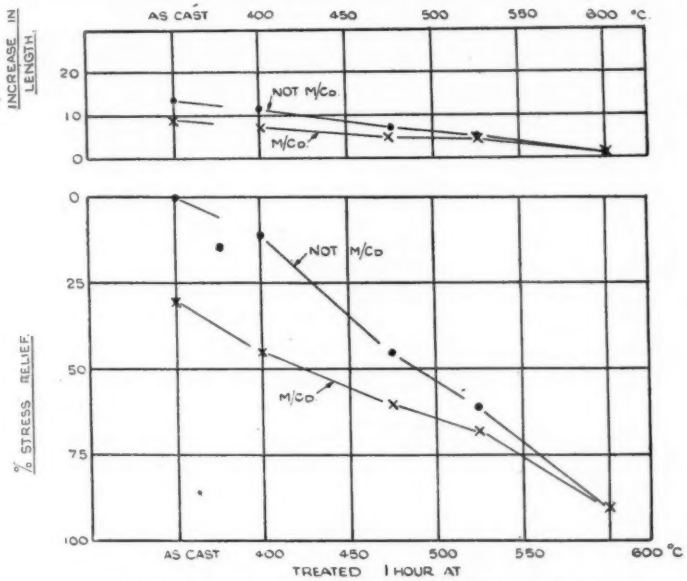

FIG. 8.—EFFECT OF MACHINING TEST-PIECES ON TWO FACES.

TABLE III.—*Analysis.—T.C.*, 2.80; *Si*, 2.62; *Mn*, 0.75; *S*, 0.028; *P*, 0.084; *Ni*, 1.30; *and Cr*, 0.17 *per cent.*
Process.—Rotary Furnace Melted, Inoculated.

Treatment.	Tensile.	T.R.S.	Defln.	B.H.N.	Impact.	Gap increase.			Percentage stress relief.
						1.	2.	Av.	
"As-cast"	22.05	38.6	0.169	255	15.8	21	22	21.5	
Weathered						14	14	14	35
400 deg. C.	23.19	38.2	0.163			24	19	21.5	0
450		37.1	0.154			18	13	15.5	28
475		35.5	0.150			12	13	12.5	42
500	21.82	37.4	0.152			11	15	13	39
525		35.9	0.148			11	12	11.5	46
550		35.1	0.148			11	10	10.5	51
600	22.45	40.0	0.171	248	14.8	7	6	6.5	70

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This series shows that machining relieves a proportion of the original stresses, with the result that the residual stress after any treatment is correspondingly reduced. It should be pointed out, however, that another test-piece machined did not show any reduction of stress when measured by the gap-increase method.

included to show that it is necessary to consider such irons carefully before undertaking stress-relieving treatment.

Discussion of Results

The combination of conclusions on each of the three aspects, time, temperature and machining, would appear to show that the best results would be obtained by rough-machining followed by stress-relief annealing at 550 to 600 deg. C., allowing as much time as possible to elapse before the final machining. Of all the

TABLE IV.—*Analysis.—T.C.*, 3.19; *Si*, 1.96; *Mn*, 0.57; *S*, 0.100; *P*, 0.68; *Ni*, 1.07; *Cr*, 0.65; *and Cu*, 0.80 *per cent. Process.—Rotary Furnace Normal Melt.*

Treatment.	Tensile.	T.R.S.	Defln.	B.H.N.	Impact.	Gap increase.			Percentage stress relief.
						1.	2.	Av.	
"As-cast"		36.1	0.132	285	10.0	18	19	18.5	
Weathered						14	15	14.5	21
400 deg. C.		36.3	0.128			21	18	19.5	−6
450		34.3	0.115			13	13	13	30
475		30.9	0.105			14	10	12	35
500		31.1	0.106			16	14	15	19
525		31.2	0.109			12	14	13	30
550		29.6	0.105			11	10	10.5	43
600		32.3	0.110	285	11.0	6	—	6	67

TABLE V.—*Test on Grade 4 B.S.S. 786 Cast Iron.*

Analysis.—T.C., 2.56; *Si*, 2.57; *Mn*, 0.72; *S*, 0.025; *Ni*, 1.07; *Cr*, 0.11; *and Mo*, 0.45 *per cent.*

Process.—Rotary Furnace Melted, Inoculated.

Treatment.	Tensile.	T.R.S.	Defln.	B.H.N.	Impact.	Gap increase.			Percentage stress relief.
						1.	2.	Av.	
"As-cast"	31.07	51.3	0.190	321	22.8	13	8	10.5	
Weathered						12	13	12.5	−19
400 deg. C.	31.01	47.5	0.169	302		7	9	8	24
450	32.01	45.9	0.162	302		7	—	7	23
475	27.12	44.2	0.161	302		11	11	11	−5
500	29.32	45.5	0.161	302		5	5	5	52
525	31.61	43.7	0.155	302		4	5	4.5	57
550	31.32	43.8	0.149	302		4	3	3.5	67
600	30.50	40.7	0.148	285	20.0	2	4	3	71

Exceptions

The fifth of the original series tested was a nickel molybdenum iron to Grade 4 BSS 786 and this has a borderline acicular structure. The results are given in Table V and it will be observed that:—(*a*) there is a falling off in hardness at the lowest treatment temperature—400 deg. C.; (*b*) there is a falling off in tensile strength and an increase in internal stress at 475 deg. C.; (*c*) the tensile strength is recovered at 525 deg. C. and is maintained up to 600 deg. C., and (*d*) the initial gap opening is much less than in any other series. It is outside the scope of this Paper to discuss the reasons for these, but the series is

factors investigated the most important seems to be the temperature of treatment and if 600 deg. C. can be permitted, all the other factors become irrelevant. The physical tests show that, for the types of iron investigated, treatment at 600 deg. C. causes practically no loss of physical properties. It is possible that this does not apply to higher carbon irons with coarser graphite structure, but it is a comparatively simple matter for any foundry to investigate the effect on the type of iron it is producing.

The form of test-piece used is not ideal for experiments in stress-relief annealing and for careful research the form of test used by Benson and Allison, in which a

bar is pre-stressed to a known amount, is more reliable. It does not lend itself, however, to any investigation on the effects of machining.

This set of experiments cannot be taken as conclusive evidence of the amount of stress relief obtainable over the whole range of irons in production and over the whole range of stresses that may occur. It can, however, be claimed that it has been shown that the present normal specification for this process, using a range 475 to 525 deg. C. does not give full stress relief and temperatures up to 600 deg. C. should be used, providing the producer is satisfied that no serious falling off of physical properties occurs at this temperature.

Acknowledgments

The Author is indebted to Mr. D. W. Berridge and other members of the staff of S. Russell & Sons, Limited, for carrying out the detail work of these investigations, and for many helpful suggestions. He is also indebted to the British Cast Iron Research Association for compiling a bibliography, a selection of which is given at the end of this Paper.

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GERMAN TECHNICAL REPORTS

Among further reports submitted by teams of industrial experts, which have visited Germany under the auspices of the British Intelligence Objectives Subcommittee, are two of interest to the foundry industry. The post-free price is given between brackets. B.I.O.S. 437—Production of cast-iron porcelain enamelled baths in Germany (1s. 7d.); and B.I.O.S. 589—German light alloy die-casting industry—machine tools for die sinking (1s. 7d.). These reports may be obtained from H.M. Stationery Office.

MR. JOHN WILMOT, M.P., Minister of Supply, last week drove off the assembly line at the Ford Works, Dagenham, the one millionth British-built Ford vehicle produced in the factory, which opened in 1931. Overseas shipments from the factory recommenced in June, 1945, the value of exports since that date being over £6,000,000.

PUBLICATIONS RECEIVED

Reports on the Reciprocal Expansion of Production in Engineering and Agriculture, No. 1.—Tractors and Arable Farm Equipment. Published by Trade Relations Research Bureau, and obtainable from the World Trade Alliance Association, Temple Chambers, Temple Avenue, London, E.C.4. Price 1s. 3d., post free.

This pamphlet is of distinct interest to foundries making agricultural machinery, especially tractors. It rightly points to the crises in Russia, when nearly all the horses were slaughtered, and in the United Kingdom during the submarine menace, both of which were largely overcome by resort to extensive mechanised farming. The booklet includes a very interesting table showing the numbers of tractors in use throughout the world, and the acreage devoted to the three major crops. The authors calculate that in order to mechanise 29 countries, no fewer than 2,400,000 agricultural tractors are required immediately, and that as an immediate measure 600,000 should be made. The British position is that 17,377 tractors were made of the four-wheeled type, 5,166 tracklayers, and 675 market garden machines in 1945, whilst this year the programme allows for a 31 per cent. increase. It needs no international statistics to impress upon British foundrymen the present urgency, because the programme for one type alone demands more foundry capacity than is possessed by all the specialised manufacturers—and they are very important concerns. However, it is interesting to know that this demand has statistical support.

Ni-resist in the Chemical and Allied Industries. Published by the Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1.

This brochure is of real value to the foundry industry, as it provides reliable data for placing before their customers engaged in the production or handling of chemicals and the like. Ni-resist is an alloyed cast iron normally containing 14 per cent. Ni, 6 per cent. Cu, and 2 per cent. Cr, and its behaviour in contact with a large range of chemicals is definitely superior to cast iron, and usually slightly superior to phosphor-bronze. The value of the figures of Table I would have been enhanced by giving more information as to the period of the tests and the shape of the test-piece, as corrosion attack is by no means a straight line curve. The various diagrams are excellently set out, whilst the illustrations have been particularly well chosen. The brochure is available to our readers on writing to the publicity department at Park Lane.

THE WOLVERHAMPTON METAL COMPANY, LIMITED, are to make application to the Council of the Stock Exchange, London, and to the Committee of the Stock Exchange, Birmingham, for permission to deal in £152,856 ordinary stock, transferable in units of 5s. each.

FOUNDRY PRACTICE FOR ENGINEERING STUDENTS

From an address by Mr. H. F. Scobie, educational assistant, American Foundrymen's Association, which was presented at the Manufacturing Processes Session, Society for Promotion of Engineering Education, at St. Louis, recently, we have extracted the following paragraphs.

Co-operation between schools and industry results in more able engineering graduates and more satisfied employers. Educational institutions which consider industrial requirements when revising curricula can expect further assistance from industry, and will have the satisfaction of knowing they are fulfilling their educational function to the maximum.

Engineering colleges have a two-fold function to perform for the foundry industry and for engineering students. All engineering students should be trained in the basic principles and applications of cast metals. In addition, those interested should be given the opportunity to train for positions in the foundry industry. Everything used and produced requires metal castings, directly or indirectly. Spending annually more than 3 billion dollars for castings of all sizes, shapes, and of some 600 alloys, manufacturers cannot afford to employ engineers who are unfamiliar with the economics of casting use, and casting design. Familiarity will be gained through a good basic course in the fundamentals of modern foundry practice, and through proper attention to cast metals in other engineering courses. Modern foundry practice, you are aware, demands close co-operation between designers, pattern-makers and foundrymen.

Importance of the Industry

The present sluggish return of the country [America] to peacetime production is due, in part, to inability of foundries to provide castings as rapidly as other industries need them. A basic industry, the foundry must return to normal before any other industry can reach full employment and production. These facts should be kept in mind by departmental heads expecting to stimulate improvement of foundries under their administration.

Colleges recognising the importance of castings set high standards for foundry instructors. Such colleges use the same care in selecting a foundry instructor that is used in selecting any other instructor. Colleges attentive to foundry industry needs devote sufficient time and thought to the problem so that the foundry instructor is not employed at the last minute. Late selection too often results in employing a man willing to take the position as foundry instructor only because he can find no other. Such an instructor is not a credit to the school, nor can he satisfactorily serve the student body or the foundry industry.

An engineering college foundry instructor should have a good educational and industrial background, as well as proved interest in castings and the foundry industry. To teach modern foundry practice, the instructor should be a graduate in metallurgy, or in chemical engineering or mechanical engineering, with electives in metallurgy. He should have had experience in several types of foundries, not only in a grey iron shop. Experience in steel and malleable foundries and in shops casting light-metal alloys, copper-base alloys, and others, is highly desirable.

Moulding, core-making, melting and other foundry techniques are necessary in a general foundry course only to the extent that they enable the embryo engineer to readily understand the use and design of castings. The older system of laboratory periods only, without formal lectures, has been discarded by some engineering colleges. Foundry instructors in progressive engineering colleges devote about half the available class hours to lecturing. Emphasis is not placed on handing down a collection of traditional knowledge, but rather on the ideas behind the tradition. Instead of "know-how," interest centres on "know-why."

Elimination of Overlapping

Pattern-making should be very closely integrated with the course in foundry practice. If the courses are not taught by the same instructor, or are not under the jurisdiction of one man, there should be agreement on their content to eliminate unnecessary overlapping. Important, also, is agreement on foundry and pattern terminology, pattern colours, allowance for draft, shrinkage and machining, etc. An engineering college course in pattern practice should not stress the use of woodworking tools or attempt to make a pattern-maker of the student. Elementary woodworking, that should have been learned in a high school or at a home work bench, has little place in a crowded engineering curriculum. The college pattern course ought to include pattern construction for maximum mouldability and economy of production, types of pattern equipment, pattern construction materials, and perhaps permanent mould construction.

APPRENTICES IN SMALLER FIRMS

The Council of Ironfoundry Associations, in Service Bulletin No. 6, have tackled the thorny problem of apprentices in medium-sized and small foundries. It cannot be said that the position has been reached where a cut-and-dried scheme can be launched. By putting a scheme in print, however, the problem is half-solved, but the chief worries are, unfamiliarity with the proposed educational schemes, and the incidence of military training which will interrupt the apprenticeship period. Another weakness is that in small concerns it might be difficult to find a craftsman who has the aptitude for teaching. Yet these are the very problems which have to be faced, and, moreover, they are not peculiar to the foundry, as other industries also have their quota of small shops. This bulletin must not be considered in a destructive frame of mind, but the small concern should ascertain if there be any plums to be picked, and reap the harvest.

Lead Casting Capacity.—We thank John Varley, Limited, Atlas Works, St. Helens, for informing us of their ability to make castings in lead weighing up to 5 tons.

FLUIDITY TESTING OF FOUNDRY ALLOYS*

American Foundrymen's Association exchange Paper to the Institute of British Foundrymen

By K. L. CLARK

(*Continued from vol.* 79, *page* 450.)

Skimmers

It is well known that the presence of slag and dross has a pronounced effect upon the apparent fluidity of a metal. The effect is more noticeable with some non-ferrous alloys than with iron-base alloys. Accordingly, very few of the investigators who have worked with irons and steels have given attention to skimming devices. However, if the intention of specifying a standard fluidity-test for all of the commonly cast metals is to be realised, it appears essential that some means be provided in the gating system to prevent floating, non-metallic material from entering the flow-channel.

A strainer-core can be inserted in the sprue in the manner employed by Curry[22] and others. However, unless the openings through the core have a total cross-sectional area which is sufficient to allow rapid filling of the sprue, it is believed that some of the reproducibility of the test is lost. Since the core must have some strength and, therefore, be relatively large in comparison with the total area of the openings, the cross-sectional area of the sprue must be considerably larger above the core than below it. Therefore, the sprue fills to a constant level less rapidly with a strainer-core than without it even though no constriction is caused by it. Moreover, the core acts to chill the metal somewhat, and it is desirable to keep the chilling action to a minimum.

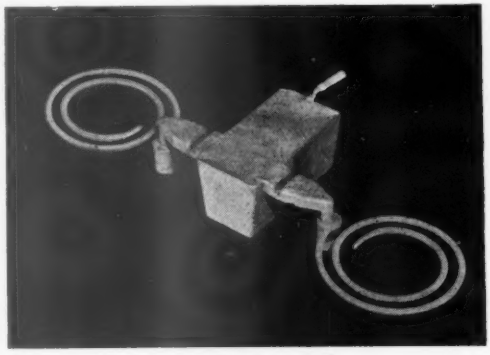


FIG. 8.—CAST PAIR OF SPIRALS (MOTT, SCHAEFER AND COOK).

Since it has been recommended that a pouring basin be made in the mould, a modification of the skimming device used by Mott, Schaefer, and Cook[105] is believed to be very satisfactory for skimming dross and slag from the metal. A photograph of a fluidity casting, taken from their report, is reproduced in Fig. 8. The suggested modification is that the section between the skimmer and the sprue be reduced to allow it to fill more completely before metal enters the sprue.

FIG. 9.—MOULD AND THERMOCOUPLE ASSEMBLY PREPARED FOR POURING (MOTT, SCHAEFER AND COOK).

Temperature-measurement and Transfer of Metal to Test-mould

For fluidity testing in the laboratory, accurate measurement of the true temperature of the metal is a very important part of the procedure, because temperature has such a profound effect upon fluidity irrespective of other conditions which may alter it. Some of the inconsistencies in reported data are probably

* Published with permission of the U.S. Navy Department without endorsement of statements or opinions of the writer. The Author is on the staff of the U.S. Naval Research Laboratory of the Office of Research and Inventions, Washington, D.C.

Fluidity Testing of Foundry Alloys

due to errors of temperature measurement. Even if the temperature of the metal is measured accurately in the furnace or in the ladle before the sample is poured into the mould, the metal can be chilled considerably as it is transferred. For example, if metal is poured directly from a crucible or lip-pour ladle, the pouring lip may be at any temperature within a wide range, depending upon a number of conditions; if the metal is dipped with a sampling spoon, the chilling effect of the spoon is dependent upon its mass, the degree of preheat, and the time required for the transfer. Thus, for laboratory tests, it is desirable to measure temperature of the metal in the fluidity-mould itself.

Mott, Schaefer, and Cook[105] have used a method which appears to be very reliable. Their technique is to place the hot-junction of a platinum, platinum-rhodium thermocouple in the pouring basin of the mould, Figs. 8 and 9, so that the temperature of the metal can be taken just before it enters the sprue. For this technique to be successful it is required that the couple respond very rapidly and the indicator or recorder be equally responsive. These investigators used a spot-welded couple with the junction no larger than the elements. This couple was pulled through a single-bore, fused-silica sheath with very thin walls so that the thermal lag was not more than four or five seconds. A rapidly responding indicator was used with the couple. It is necessary to have metal flowing into the pouring basin for a period which is long enough for the couple to respond to the true temperature of the metal before it enters the sprue. This condition can be controlled by establishing suitable dimensions for the pouring-basin and by regulating the rate of pouring with a pouring-cup. Mott, Schaefer, and Cook used a pouring basin which is roughly cubical in shape with the length of each edge being approximately 4½ in.

Temperature-measurements are not required for quality-control tests of fluidity in the shop. It should be emphasised again that useful information can be gained from this type of fluidity testing only by correlation of test-results with observations of fluid performance of the metal on the casting floor for each shop. Therefore, the important thing to be observed in shop-practice is that the metal be transferred to the test-mould in exactly the same manner for each test. For example, the procedure at the U.S. Naval Research Laboratory for making fluidity tests of steel in the

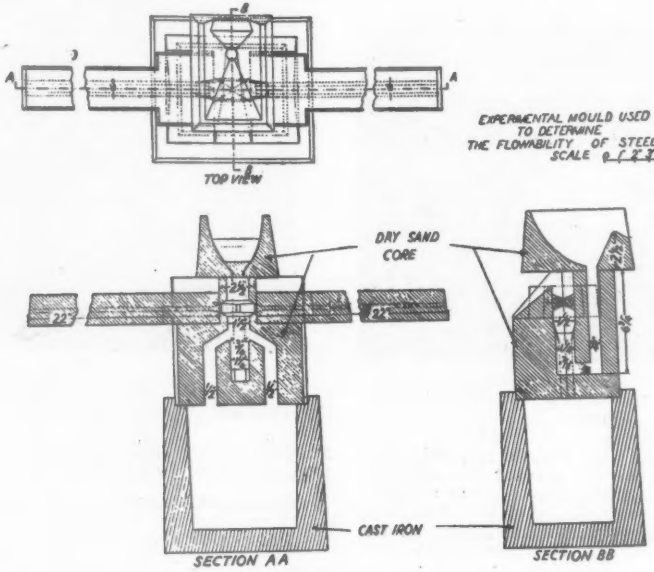
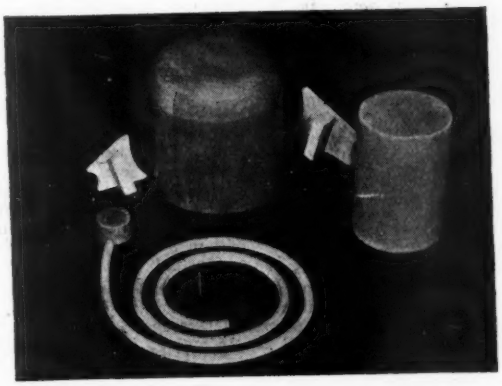
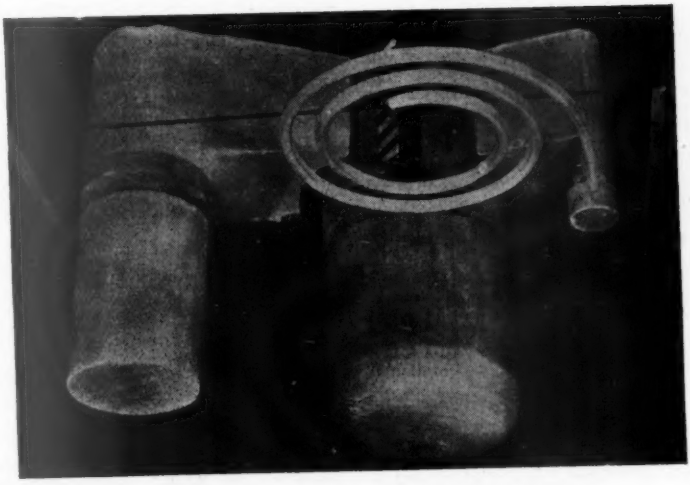


FIG. 10.—DETAIL DRAWING OF EXPERIMENTAL MOULD USED TO DETERMINE THE FLOWABILITY OF STEEL IN FOUNDRY TRIALS (KRON AND LORIG).

arc-furnace for control purposes is as follows: (1) The bath is rabbled just before a sample is taken; (2) 10-lb sampling spoon, initially dry and at room temperature, is slagged for a period of 10 secs. as the melter counts, "One-thousand and one, one-thousand and two, etc."; (3) a spoonful of metal is dipped from a fixed position with respect to the electrodes and is withdrawn quickly, but not hurriedly, from the furnace; (4) the metal is deoxidised with a strip of aluminium unless the final additions have been made to the furnace, and (5) the spoon is inverted just above the pouring cup, which is centred over the pouring basin. The average deviation from the standard time-cycle for steps, 3, 4 and 5 is approximately 3 secs.



SPACED PROPERLY FOR RAMMING IN DRAG.



INDIVIDUAL PARTS SEPARATED BY GLASS PLATE.

FIG. 11.—PATTERN FOR LARGE FLUIDITY TEST-PIECE (TAYLOR, ROMINSKI AND BRIGGS).

Fluidity Testing of Foundry Alloys

Sampling from Bottom-pouring Ladles

When it is desirable to make fluidity-tests from a bottom-pouring ladle, some provision must be made to deal with the extraordinary force of the metal as it comes from the nozzle. Kron and Lorig[79] developed a test-mould (Fig. 10), with which they were able to pour fluidity tests from a bottom-pouring ladle containing 27 tons of steel. The flow-channel of this mould is a modification of that developed by Ruff. Only a few tests were made with the mould, and the data are insufficient to support a recommendation for its adoption.

Taylor, Rominski, and Briggs altered the pouring basin of their laboratory test-mould and placed a baffle-core between the pouring basin and the sprue so that samples of steel could be taken from a bottom-pouring ladle. Other details are the same as those of the test-piece for laboratory work or tests on the melting floor, where a sampling spoon is used to transfer the metal to the mould. A photograph of the pattern for this test-mould is shown in Fig. 11. Satisfactory tests were obtained with the large test-piece, and it is believed to be generally acceptable for use with a bottom-pouring ladle.

Shop-tests *v.* Laboratory-tests

The idea has been emphasised that one well designed test-piece should be suitable for both shop-tests and laboratory-tests of fluidity. The flow-channel, sprue, and pressure-load of molten metal should be identical in all cases. However, for the pouring-basin, two or possibly three designs are necessary because of the differences in requirements of pouring methods. For laboratory-tests, the pouring basin must be large enough so that accurate temperature-measurements can be made of the metal as it enters the mould. The pouring-basin of a mould which is to receive metal from a bottom-pouring ladle should also be large. By contrast, a smaller pouring-basin is required for shop-tests if metal is to be removed from a furnace with a sampling spoon.

It is not suggested that shop tests can be made with the same control and care with which a laboratory-test is conducted. However, it is believed that the results of fluidity-testing, obtained from moulds, having the same pressure-head of molten metal, flow-channel and sprue, although the pouring-basins are enough different in design to satisfy the requirements stated above, would be sufficiently comparable so that operating personnel and laboratory personnel could exchange information and improve practice for the benefit of the industry.

Summary of Recommendations

A review of available information indicates that a standard fluidity test-piece should have design details and provisions for operations similar to the following:

Flow-Channel.—Half-circular or trapezoidal cross-section; cross-sectional area should be established at some value within the range of $\frac{1}{16}$ to $\frac{1}{4}$ sq. in.; length of approximately 60 in.; and spiral configuration with a vent at the end.

Mould Material.—Green sand without a mould-wash; A.F.A. grain size of 80 plus or minus 5, and minimum A.F.A. permeability of 75.

Gating Arrangement.—Vertical sprue with a cross-sectional area approximately six times that of the flow-channel; receiving well at the base of the sprue only slightly larger in diameter than the sprue.

Pressure Head.—Exact distance established within the range of 1 to 2 in. from plane of discharge from pouring-basin to sprue; variation regulated to $\frac{1}{4}$ in. by discharge levels from pouring-basin.

Pouring-Basin.—At least two designs are necessary—one should be sufficiently large to dissipate kinetic energy of metal being taken from a bottom-pouring ladle and allow response of pyrometric equipment for temperature-measurement in laboratory tests, the other should be small enough so that the sample can be taken with a spoon; provided with an overflow to maintain a constant pressure head within the limits mentioned.

Skimmers.—Baffle core placed between pouring-basin and sprue to skim non-metallic material from metal entering sprue.

Temperature Measurement for Laboratory Tests.—Lightly sheathed platinum—platinum, rhodium thermocouple inserted in pouring-basin; high-speed indicator or recorder used

Fluidity Sampling from Bottom-Pour Ladles.—Mould designed so that all details except pouring-basin are the same as the test-mould for samples taken with spoons or from lip-pour ladles.

Acknowledgment

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BOOK REVIEW

Handbook of Cupola Operation. Published by the American Foundrymen's Association, 222, West Adams Street, Chicago, 6, Illinois, U.S.A., and obtainable from the Penton Publishing Company, Limited, 2, Caxton House, London, S.W.1. Price 28s. 6d.

A reference book on cupola practice is very different from a technical contribution to a learned society. The latter must, *force majeure*, be limited to one or a few phases of what is really a quite extensive subject, whilst the former must indicate that there are a number of methods of "killing a pig." Moreover, a textbook can never be quite up to date. There are 24 chapters, of which about half are devoted to cognate subjects such as historical; temperature measurement; foundry coke; pig-iron; gas analysers; constitution of cast iron, and so forth; and these useful sections will be omitted from this review. Chapter II—"The Operation of the Cupola"—is an elementary account of the running of a plant, and five methods are detailed for the preparation of the breast and tap-hole, and seven for the lighting-up of the furnace. Table II details the general charging directions for cupolas and in 18 sizes covering from an 18-in. to a 7-ft. dia. furnace. To do this 21 columns are necessary. Moreover, nobody will go far wrong in following the data given. The whole chapter is full of quite useful tips, such as the use of the cupola dump coke for heating ladles; the greasing of ladle templates with a heavy oil lubricant to facilitate its withdrawal; or the illustrating of a gadget for the removal of the dump from beneath the cupola. The chapter, which runs to nearly 100 pages, finishes by tabulating 30 suggestions for better cupola operation; the reviewer would add one more—test the weighing machine periodically.

Chapter II reviews the physical design of the cupola, disregarding the auxiliary equipment dealt with elsewhere. As blackout conditions were never so serious as in this country, consideration of the top of the cupola ends with the spark arrester. One is illustrated in combination with a gas washer to prevent the expulsion of spark and dust to the detriment of the roof guttering.

After a short, but adequate, chapter on tuyeres, there is one on special cupolas, which is confined to the balance-blast system. The hot-blast contraptions are dealt with in detail later, but the work of Erz and Greiner, Poumay, and others, should be mentioned in a textbook. This chapter terminates, as do several others, with a specialised bibliography.

The refractory lining is covered in Chapter VI, and whilst being in every way adequate, is not too interesting to British readers, as the raw materials differ somewhat from American.

The section dealing with the mechanical charging of cupolas covers the main types, all of which are to be found in this country, but extension is still warranted. Reading between the lines in the chapter devoted to blowing equipment, it appears that the positive displacement blower has more points in its favour, especially for the larger installations, than is generally recognised in this country. On temperature measuring equipment, too little space is devoted to immersion pyrometers, which are increasing in popularity on this side of the Atlantic. Some quite nice plant is illustrated in the chapter covering forehearths and receiving ladles, and again, British as well as American practice is mirrored. Because of the existence of larger plants in the States, the question of slag disposal is more insistent, and this chapter is well worth study by the British, as cupola size is tending to grow. Blast conditioning, which includes the hot-blast cupola, is a subject which has recently been brought up to date by Mr. E. Longden. The account given in this book is excellent so far as American developments have gone—which is a long way! Increasing attention, however, must now be given to European efforts. Going right on to Chapter XX, the reviewer thinks that alkali desulphurisers and desulphurising needs revision in the light of more recent researches. Especially is this so in respect to ladle linings for the carrying out of the soda-ash process. It is interesting to learn that the idea is British and was invented about 1850 by Sir Thomas Horseley.

To summarise, the reviewer believes that the book will be well received in British circles. It is essentially practical and contains a wealth of knowledge to which the reader can refer with confidence. The book was heavily subsidised by the American foundry industry; its production has been carried through by the best brains in the American grey-iron foundry industry, and is thus excellent value for money. As the book is bound to have a wide circle of readers outside the United States, the inclusion of just one more appendix of conversion factors would be welcome. The next edition should have some reference to Renshaw's work on the basic cupola, as it does show potentialities under certain circumstances.

V. C. F.

FLUIDITY TESTING OF FOUNDRY ALLOYS

(*Continued from previous page.*)

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HOT-TEARING TENDENCIES OF ALUMINIUM CASTING ALLOYS

By D. G. C. LEES, M.A.*

The following is a summary by the Author of a Paper published by the Institute of Metals. The hot-tearing tendencies of a number of aluminium alloys have been studied experimentally and it is now possible to outline the mechanism by which tearing occurs.

One of the important properties determining the suitability of an alloy for use in the foundry is its tendency to show "hot-tears"—in other words, cracks in the finished casting due to the restraint of free contraction during cooling from the liquid state to the solid. In the course of work by the British Non-ferrous Metals Research Association on the casting characteristics of aluminium alloys, the hot-tearing behaviour of a number of commercially used alloys has been studied under controlled conditions and out of this work it has been possible to outline the mechanism of hot-tearing and to make recommendations for its avoidance.

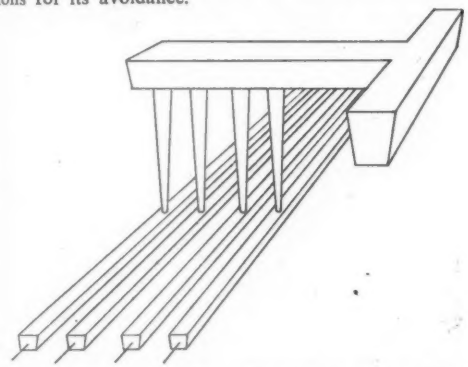

FIG. 1.—HOT-TEARING TEST CASTING FOR USE IN SAND MOULDS.

Experimental Methods

Two tests have been developed, one in sand moulds and one in copper dies. Of these, the test in sand moulds is suitable for use on alloys which are particularly prone to hot-tearing, and the other is suitable for testing alloys with high resistance to tearing.

(*a*) *Test in sand moulds.*—A perspective view of this tets is given in Fig. 1. Bars 11 in. long and $\frac{1}{4}$ in. square were poured from a common runner and the contraction of the bars was restrained by bolts cast in the ends and passing through slots in the moulding box, the bolts being free to move with the contraction of the bar to various amounts before the restraining nuts bore on the outer wall of the box. Tears tended to occur in the hotter parts of the bars near the ingates, and the alloys were classified according to the degree of restraint required to produce a tear.

(*b*) *Test in copper dies.*—The test casting used is illustrated in Fig. 2. A simple cylinder is cast vertically with flanges at the upper and lower ends. Four different dies were used, giving shanks varying in diameter from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in., thus providing tests of decreasing severity. The copper dies were used at 200 deg. C. after coating the surface with acetylene soot.

For both tests the alloys were cast after suitable degassing treatments at 720 deg. C.

Susceptibility of Commercial Alloys to Hot-tearing

The greatest resistance to tearing was found to be possessed by the aluminium-silicon eutectic alloys L.33 and Alpax γ, followed by D.T.D. 424 alloy and the 90/10 aluminium-magnesium alloy (D.T.D. 300). No tearing was found in the eutectic alloys even in the $\frac{1}{4}$-in. dia. shank test, whereas a number of alloys showed tearing even in the $1\frac{1}{2}$-in. shank test. These alloys included L.11, RR.50, NA.226, 2L5, RR.72B, and Y alloy, and discrimination between them was

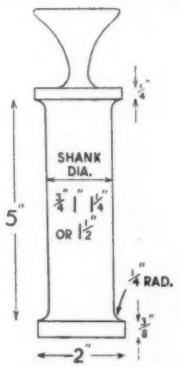

FIG. 2.—CASTING FOR HOT-TEAR TEST IN COPPER DIE.

obtained by using the test in sand moulds, L.11, RR.50 and Y alloy proving superior to the others of this group.

Susceptibility of Some Simple Alloys to Hot-tearing

The results of the tests on the commercial alloys suggested that eutectic alloys show the greatest resistance to hot-tearing, and tests were therefore made to examine the behaviour of different alloys in the simple eutectiferous systems aluminium-copper and aluminium-silicon. It is clear from the results of these tests that the generalisation suggested by the work on commercial alloys is true, namely, that the susceptibility to tearing diminishes with increasing eutectic content. Thus, an alloy containing 0.75 per cent. silicon tore in the $1\frac{1}{2}$-in. dia. shank test; with 1.68 silicon,

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Hot-tearing Tendencies

tearing was found in the 1¼-in. dia. test; with 3.42 per cent. silicon tearing was found in the ¾-in. dia. test, and with 3.99 per cent. and above no tearing was found even in the most severe test, *i.e.*, the ½-in. dia. die.

Effect of Grain Size and Dissolved Gases

Results show that coarse grained material is invariably more prone to tearing than fine grained metal of the same composition. Thus an alloy containing 5.5 per cent. magnesium was found to tear in the 1-in. dia. die, whereas the addition of 0.1 per cent. of titanium, which considerably reduced the grain size, eliminated tearing in this test.

It is well known in the die casting industry that dissolved gases in the melt reduce the susceptibility to hot-tearing, and it has been found that the present tests well illustrate this effect.

Mechanism of Hot-tearing

The main factors affecting the hot-tearing behaviour are constitution, grain-size and gas content of the melt. These findings can be explained by the following consideration of the freezing process.

When alloys of the type considered (other than eutectics) freeze in a mould, the casting generally consists of a mass of primary crystals, mixed with residual liquid of lower melting point, the primaries being at varying stages of growth according to the temperature prevailing at the different parts of the casting. Until the primaries are large enough to touch each other and to form a coherent network, shrinkage is compensated by a general consolidation known as "mass-feeding," and at this stage there is no danger of tearing. When the primaries have grown sufficiently to interlock and to form a coherent mass, their solid shrinkage will set up stresses if free contraction is restrained, and tearing may result, especially at local hot spots where the network is less coherent. Clearly the stage at which the primaries form a coherent network will be later for alloys of higher eutectic content and it is thus intelligible that the liability to hot-tearing decreases with increase in eutectic content.

The mechanism described above clearly implies that tearing takes place above the solidus and this was shown to be the case by relaxing the constraint on the bars in the sand mould test at various times after pouring a 96/4 aluminium-copper alloy. At the point where the tear occurred only about 80 per cent. of the alloy was frozen at the time of tearing.

If a tear has actually occurred it remains possible that it might be healed by the flow of residual liquid within the network. Actual evidence of such "healing" has been found in a commercial casting in a 96/4 aluminium-copper alloy. Free contraction was somewhat restrained by baked cores, and tears frequently occurred, although in this particular casting eutectic liquid flowed from a nearby feeder head and an incipient tear was healed. Fig. 3 shows a fairly "wide" band of eutectic between two regions consisting mainly of a solid solution. Similar effects are reported to have been found in steel castings. The amount of residual liquid available will clearly be related to the eutectic content, and as stated above, the tendency to hot-tearing has been found to fall off with increasing eutectic content. For the rather complex alloys commonly used in casting the eutectic content is mainly governed by the copper and silicon contents.

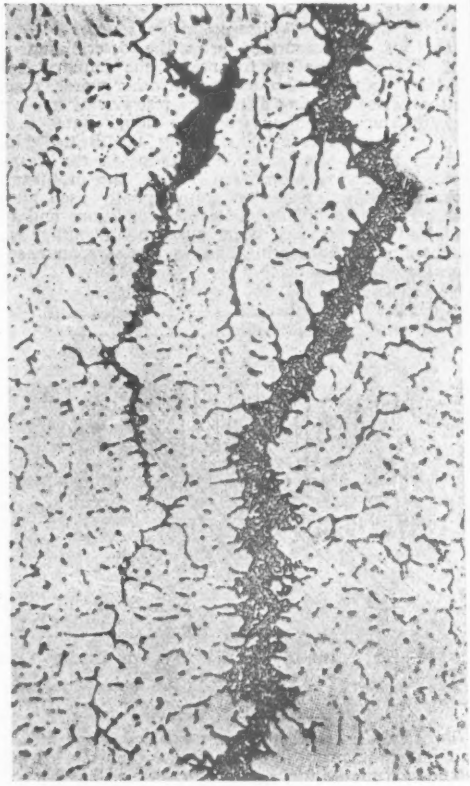

FIG. 3.—INCIPIENT HOT-TEAR IN 96/4 ALUMINIUM COPPER ALLOY HEALED BY BAND OF EUTECTIC. (× 50).

The improved hot-tearing resistance shown by alloys of fine grain-size may be easily understood in the light of the foregoing discussion. Other things being equal, a coarse-grained casting with well-developed dendritic arms will form a coherent network at an earlier stage in freezing than will a fine-grained casting of similar constitution. Hence the amount of contraction occurring between this stage and the end of solidification is increased and there is a greater danger of tearing.

The presence of gas in the melt probably helps to minimise tearing by forcing residual liquid into small tears in the network, thus aiding the healing process outlined above.

Relation Between Hot-tearing and Cracking in Welding

Since the process of fusion welding consists essentially in making a small casting between two pieces of solid metal, it is not surprising that there is a close relationship between the tendencies of alloys to hot-tear in casting and to crack when welded under constraint. For instance, the aluminium-silicon alloys are completely free from any tendency to crack in welding, and aluminium alloys containing 5 per cent. silicon and 2.5 per cent. copper (*i.e.*, essentially similar to D.T.D.424 alloy) have been shown to behave very well in welding tests. The use of such alloys for welding purposes is covered by British Patent 575,589, held by the British Non-ferrous Metals Research Association.

It is probable that alloys having a long freezing range will be more prone to tearing than otherwise similar alloys of short freezing range, since the amount of contraction occurring between the formation of a coherent primary network and the final solidification will be greater. The presence of arsenic in copper has been found to increase the tendency to crack during welding under restraint and this is ascribed to the increased freezing range.

NEUTRALISATION OF SULPHUR IN CAST IRON BY VARIOUS ALLOYING ELEMENTS

Mr. H. Morrogh, of the British Cast Iron Research Association, in a Paper which he has prepared for presentation to the Iron and Steel Institute, has included the following summary and conclusions:—

(1) The influence of nickel in amounts up to 20 per cent., of molybdenum up to 2 per cent., of copper up to 5.9 per cent., of chromium up to 28 per cent., and of aluminium up to 7.7 per cent., on the sulphide phases in low-manganese, high-sulphur irons, has been studied.

(2) With the exception of nickel, all these elements can combine with sulphur (in the absence of sufficient manganese to form manganese sulphide) to give characteristic sulphides.

(3) In the cases of copper, chromium, and aluminium, definite sulphides may be detected.

(4) Nickel and copper behave similarly in neutralising the carbide-stabilising effect of iron sulphide, but nickel appears to exert a stronger influence.

(5) With high-sulphur and low-manganese contents, the addition of nickel or copper can give rise to abnormal graphite structures possessing features suggesting graphitisation after solidification.

(6) As far as commercial irons of to-day are concerned, the sulphides described may occur in the case of copper, chromium, and aluminium irons.

(7) No definite sulphide was attributed to molybdenum, although that element definitely had an effect on the mode of occurrence of iron sulphide when 2 per cent. of molybdenum was present.

(8) Either a solid solution of Cu_2S in FeS or a double sulphide of these two can exist in cast iron.

(9) A eutectic of this solid solution (or double sulphide) and Cu_2S may occur in cast iron.

(10) Cuprous sulphide (Cu_2S) may exist in varying amounts in solution in manganese sulphide in cast iron.

(11) Chromium sulphide (CrS) may occur associated with iron sulphide in striations or with manganese sulphide in a eutectiform pattern of spots.

(12) The grey chromium sulphide phase may be chromium sulphide with iron sulphide and/or manganese sulphide in solid solution.

(13) With approximately 30 per cent. of chromium, the chromium sulphide had a khaki colour and showed a faint reflex pleochroism. With chromium contents of this order the pleochroic phase replaced the iron sulphide completely.

(14) With low manganese contents aluminium sulphide (Al_2S_3) containing manganese sulphide in solid solution may occur in cast iron.

(15) In no case did pouring temperature appear to have any influence on the form of the sulphides in any of the compositions investigated.

(16) It should be remembered that the above remarks all apply to irons of very high-sulphur and low-manganese contents.

BOOK REVIEW

Steel—The Facts about Monopoly and Nationalisation, by Henry Owen. Published by Lawrence & Wishart, Limited, 2, Southampton Place, London, W.C.1. Price 4s. net.

The title of the book is distinctly misleading, as it deals with iron quite extensively; there has never been a monopoly, and nationalisation remains a dream. Moreover, no case is made out for nationalisation; but, as is common knowledge, there is room for rationalisation—a feature interrupted by six years of war and Government interference. Amongst the "facts" the reader is expected to assimilate is that the British steelworker is the "finest in the world." The reviewer's personal experience of steel smelters is that they are a fine type the world over, but they are much of a muchness. On Mondays few are at their best after a week-end's rest! A second so-called fact is that "foreigners are usually pigheaded." A third is that Allied Ironfounders, Limited, have taken over 18 Scottish firms. One could continue at some length in this strain, but the reviewer will conclude as he started, that as a factual picture of the iron and steel industry this book is quite inadequate.

V. C. F.

SCRAP TO THE RESCUE

By "ONLOOKER"

At a time when virgin metals, particularly lead and copper, are in short supply, it is all to the good that the Ministry of Supply have decided to release information in respect of scrap. The figures made public relate only to the tonnage controlled by the Government, and, of course, this does supply all the details necessary for a correct appraisal of the position in the country, but it goes a long way, for the Ministry hold most of the secondary metal on hand. It is understood that the question of obtaining statistical data relating to secondary metal in the United Kingdom has been under review from time to time by the National Association of Non-ferrous Scrap Metal Merchants, but the problem is not one that lends itself to easy solution, and there is no news of any arrangements for the co-ordination of figures with a view to publication of a bulk figure. The British Non-ferrous Metals Federation has a statistical section which is furnishing monthly figures relating to virgin copper consumption and also details of the copper content of scrap used. This monthly table covers much ground, but does not present a complete picture of what is going on in the country as a whole. However, one way and another the position is certainly better than it was in pre-war days, for a start has been made and the industry is obtaining a good deal more in the way of news than formerly.

Stock Position

As to the actual figures of the Ministry's published statement, these show that the stock of scrap "on charge" (*i.e.*, available for sale) at June 30, was 199,238 tons, which is about 8,000 tons more than at April 30. Of the June total, and indeed at the end of April also, about half consisted of Q.F. cases and muffled small arms ammunition cases, while nearly 30,000 tons was in the form of 70/30 brass ingots. Of the balance, upwards of 20,000 tons was listed as "copper and copper alloy," which presumably included brass of a copper content below 70 per cent., and probably also higher copper material, such as gunmetal and bronze. "Other grades," as usually happens when bulk quantities of secondary metal are broken up into sub-divisions for purposes of description, was a fairly big proportion of the whole, and amounted at June 30 to 51,649 tons. In this category was included mixed metal, Admiralty and Army scrap, and one must suppose that much of the scrap belonged to a category in which sorting was a vital necessity. As might be expected in view of the serious shortage of virgin lead, the Ministry's holding of secondary lead and lead alloy was only about 1,500 tons at June 30. Sales for the 2-month period June/July came to 18,889 tons, of which 4,466 tons consisted of Q.F. and muffled cases (rather less than most people would have expected), and 12,204 tons of copper and copper alloy. During the same period 7,639 tons were put out to tender, nearly 70 per cent. of which consisted of lead (probably antimonial). These figures are sufficient to show that the Government are doing a big business in scrap, but many people believe they could do even more were the comparison between the cost of this secondary metal with virgin more favourable to the consumer, for at these high price levels this aspect of things is more than ever important.

Overseas Refiners Called In

An interesting development in the scrap situation is the report that the Ministry of Supply have arranged a contract with refiners in the United States and Canada for the refining on toll of approximately 100,000 tons of secondary brass material, including 70/30 ingots and probably Q.F. cases and muffled S.A.A. cases. This step is somewhat revolutionary in character, inasmuch as the type of scrap involved is all high grade material, but if assistance is forthcoming for the virgin copper supply position—now sadly out of balance—then there will be little disposition to blame, and indeed good reason to praise, the Government for the action they are taking. In the ordinary course it obviously would not be economical to condemn first-class brass scrap, eminently suitable for alloy making, to submit to a process intended to release only the copper, for it must be presumed that the zinc will be lost, at any rate so far as the Ministry are concerned. As already mentioned, however, copper is in short supply due to strikes and other checks to production, and the matter is one of expediency. Moreover, the Government have ample stocks of this brass scrap, and further supplies are coming forward all the time. Incidentally, it would appear that the 70/30 ingots are not popular with consumers, perhaps on account of their high price, and can therefore be more easily released for this refining operation. It has always been realised that scrap constitutes a valuable "iron ration" for the non-ferrous trade in Britain, and on this occasion it has certainly come to the rescue. There may be some disposition to ask whether this refining process could not have been performed in this country, but fire refineries are very heavily engaged already and there is no electrolytic plant. After the first world war a good deal of iron battlefield scrap was run down to standard copper, which was eventually shipped to America, but this quality would not help this country much to-day.

DAVID BROWN & SONS (HUDDERSFIELD), LIMITED, have had in operation an apprentice training scheme for many years at their Huddersfield works, the first venture in this connection being made as far back as 1912, when the firm set up a special training school separate from the works to instruct youths in the traditions and skill of the trade. This scheme, however, stopped short at the point of practical work, but steps were soon taken to remedy this deficiency, and the scheme was extended into a full plan of apprentice training carried out on the works premises in a department completely separated from the manufacturing organisation. The shop is a model of modernity, it being designed to prevent eye weariness, which leads to boredom and personal heedlessness.

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IMPORTS AND EXPORTS OF IRON AND STEEL

BOARD OF TRADE RETURNS FOR JULY

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in July and in the first seven months of 1946. Figures for seven-twelfths of 1938 are given for purposes of comparison.

Total Exports of Iron and Steel.

Destination.	July, 1946.	Seven months ended July.	Seven-twelfths of 1938.
	Tons.	Tons.	Tons.
Eire	3,453	39,604	32,503
Channel Islands	382	3,285	4,326
Palestine	13,393	60,365	4,708
British West Africa	2,794	25,443	29,017
Union of South Africa	18,786	139,818	134,801
Northern Rhodesia	227	2,093	12,002
Southern Rhodesia	1,370	35,461	21,124
British East Africa	4,569	16,108	15,127
British India	6,669	46,670	92,562
Burma	1,185	8,621	10,799
British Malaya	2,763	20,216	38,841
Ceylon	1,329	7,623	15,185
Hong Kong	1,299	10,831	13,764
Australia	2,561	19,924	99,694
New Zealand	2,963	27,903	76,932
Canada	760	4,507	49,822
British West India Islands	2,923	14,648	25,813
Anglo-Egyptian Sudan	2,916	10,599	4,836
Other British Countries	2,937	16,747	12,790
Soviet Union	—	2	2,537
Finland	6,618	28,444	10,271
Norway	6,013	50,023	11,826
Iceland	1,037	7,719	384
Denmark	30,843	145,823	50,899
Poland	222	12,872	1,451
Netherlands	12,544	109,657	30,076
Dutch East Indies	2,863	5,352	15,929
Dutch West India Islands	1,398	6,625	1,437
Belgium	1,828	19,562	11,856
France	8,303	50,647	7,809
Portugal	3,774	31,652	4,499
Portuguese East Africa	598	2,789	8,295
Spain	372	6,870	4,529
Italy	2,805	3,549	2,998
Greece	2,022	7,116	1,022
Turkey	1,488	8,408	8,025
Egypt	6,386	66,684	20,072
Iraq	7,019	36,916	15,015
Iran	7,860	59,071	64,388
China	2,381	11,309	12,910
U.S.A.	92	528	1,276
Venezuela	3,901	20,669	2,727
Ecuador	135	1,997	929
Chile	167	3,381	3,671
Brazil	4,317	29,967	9,911
Uruguay	3,350	7,052	4,426
Argentine	13,379	52,717	46,291
Other Foreign Countries	31,364	151,060	67,500
Total	236,358	1,448,927	1,117,594

AFTER BEING ON STRIKE over a week, 200 employees at the Union Foundry of R. W. Crosthwaite, Limited, Thornaby-on-Tees, decided to return to work. The stoppage occurred as a result of a dispute between two unions. The matter is being referred to arbitration.

Total Imports of Iron and Steel.

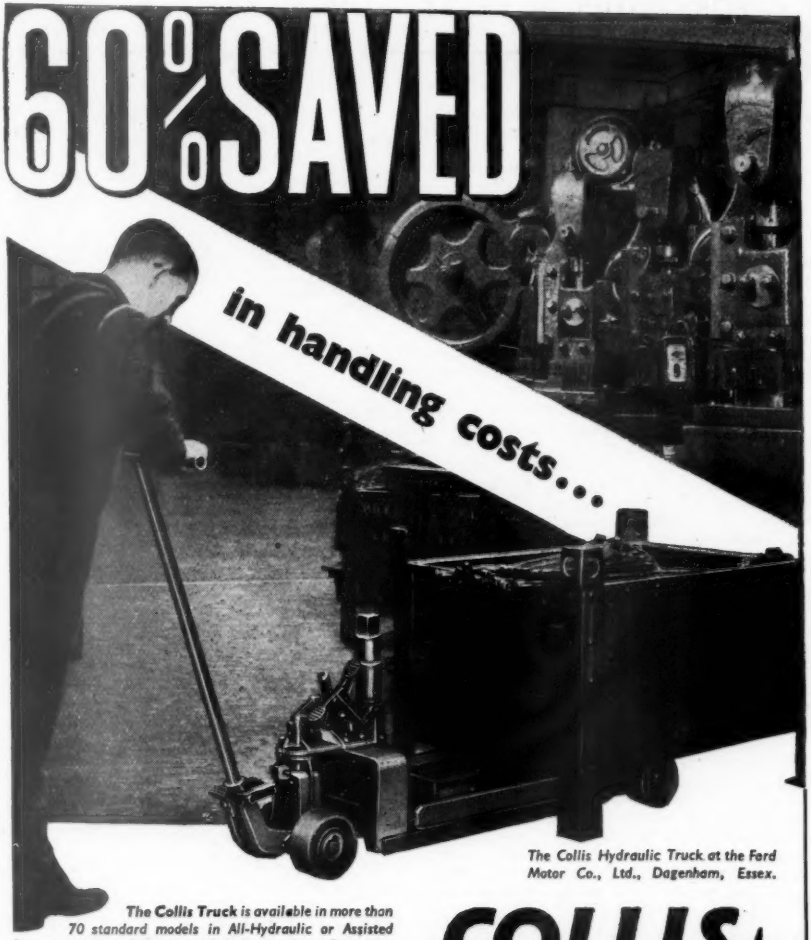
From	July, 1946.	Seven months ended July.	Seven-twelfths of 1938.
	Tons.	Tons.	Tons.
British India	—	10,977	90,786
Australia	12,334	60,256	21
Canada	9,216	84,088	68,469
Other British Countries	106	253	3,296
Sweden	359	1,610	52,381
Norway	445	4,306	19,702
Belgium	81	2,173	159,647
Luxemburg	—	15	34,184
France	64	139	150,119
U.S.A.	10,496	95,636	117,070
Other Foreign Countries	110	554	88,520
Total	33,211	260,007	784,157
Iron ore and concentrates—			
Manganiferous	9,034	65,234	36,332
Other sorts	625,453	3,682,737	2,976,091
Iron and steel, scrap and waste, fit only for the recovery of metal	38,876	280,808	368,785

Exports of Iron and Steel by Products.

Product.	July, 1946.	Seven months ended July.	Seven-twelfths of 1938.
	Tons.	Tons.	Tons.
Pig-iron	2,313	5,575	54,799
Ferro-alloys, etc.—			
Ferro-tungsten	2	206	301
Spiegeleisen and ferro-manganese	5,527	37,382	3,031
All other descriptions*	153	749	611
Ingots, blooms, billets and slabs	875	2,408	5,684
Iron bars and rods	843	7,211	1,865
Steel and tinplate bars	—	221	7,222
Wire rods and bright steel bars	6,241	34,286	5,698
Other steel bars and rods	26,061	164,414	59,503
Special steel	1,781	10,359	2,877
Angles, shapes and sections	14,712	93,150	39,319
Castings and forgings	272	1,791	944
Girders, beams, joists and pillars	4,135	46,374	19,525
Hoop and strip	7,833	49,661	21,803
Plates, ¼ in. thick and over	30,117	203,981	76,395
Black plates	1,927	16,497	8,481
Black sheets	5,946	27,920	37,048
Galvanised sheets	4,366	18,876	85,712
Tinplates	8,750	63,145	186,266
Tinned sheets	214	1,515	823
Terneplates	131	477	2,523
Decorated tinplates	9	412	2,548
Cast-iron pipes, up to 6-in. dia.	4,348	25,376	28,541
Do., over 6-in. dia.	5,208	20,459	25,062
Wrought-iron tubes	25,160	160,382	128,317
Steel rails	19,885	118,377	61,833
Sleepers and fishplates	9,874	69,303	14,807
Other railway material	2,921	13,970	15,617
Wire	7,122	46,487	32,190
Wire manufactures	3,500	19,432	17,202
Nails, tacks, etc.	944	4,917	2,221
Rivets and washers	997	5,421	4,979
Wood screws	590	3,468	1,465
Bolts, nuts, and metal screws	2,430	14,178	10,251
Stoves, grates, etc.	458	3,379	5,338
Sanitary cisterns	124	628	1,640
Fencing material	135	2,238	2,993
Anchors, etc.	713	3,238	3,696
Chains	1,011	5,204	3,670
Springs	391	3,813	2,293
Hollow-ware	11,102	47,266	6,244
All other manufactures	17,237	94,781	126,268
Total	236,358	1,448,927	1,117,594

* The figures for 1946 are not completely comparable with those of earlier years.

60% SAVED



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EXPORT OPPORTUNITIES IN HEAVY ENGINEERING

GOVERNMENT'S OBLIGATIONS TO BRITISH INDUSTRY

"The reduction in the trading profit arises almost entirely through shortage of work at our engineering establishments in Sheffield and Glasgow," says Mr. D. F. Campbell (chairman), in his statement with the annual report of the Davy & United Engineering Company, Limited. This has been caused, not so much by the transition from war to peace within their group of companies, but by the problems which beset their principal customers, the iron and steel industries, he continues. Heavy-engineering schemes take considerable time to plan and mature and it was expected that some time lag would occur between the end of the war and the placing by the British steel industry of orders for the equipment included in its very large programme of modernisation. While this delay, which has been accentuated by political events, is unfortunate, it is certain that a very large programme of new work will have to be carried out. In the meantime they have been renewing their export connections, many of which were broken by the war.

Mr. Campbell mentions that during the year, several of the company's engineers have visited Germany to study the technical developments made during the war period. These investigations have been most instructive and have proved conclusively that in many directions British and American designs of rolling-mill plant are substantially in advance of the corresponding German equipment. "It is now clearly established that the German Government was making very substantial contributions to German industry to assist export trade. Our Government should ensure that never again can foreign manufacturers have advantages which militate unfairly against the steady development and progress of a key industry vital to the nation in times of emergency." Mr. Campbell states that the output of the heavy German engineering works in their branch of industry was from two to three times that of Great Britain, and more than two-thirds of his was exported before the war. As this productive capacity is now being greatly reduced, there is clearly an opportunity of extensive export trade to those countries which have neither the engineering skill nor the heavy workshops to produce steel and non-ferrrous works machinery.

WELDING OF LIGHT ALLOYS

A symposium on the welding of light alloys, organised by the British Welding Research Association, will be held on October 16 and 17, in the Henry Jarvis Hall of the Royal Institute of British Architects, 66, Portland Place, London, W.1. The programme will include four sessions, dealing with (1) development of high-strength aluminium alloys for welding; (2) pressure welding and flash welding of light alloys; (3) spot welding of light alloys, and (4) welding of magnesium alloys. Demonstrations and exhibits will be arranged at the offices of the Association at 29, Park Crescent, W.1.

UNITED KINGDOM TIN POSITION

The Ministry of Supply has released the following figures showing the United Kingdom tin position for the month of July:—

	Ministry	Consumers'
Tin metal:	Long Tons	Long Tons
Stocks on July 1	10,989	3,430
Arrivals	—	—
Production	2,706	—
Total	13,695	3,430
Deliveries:		
To U.K. consumers	—	2,203
For export	4,037	—
Consumption	—	2,135
Stocks on July 31	9,658	3,498*
Tin ore (tin content):		
Stocks on July 1	7,753	—
Stocks on July 31	6,935	—

* Calculated. Reported 3,420 tons.

CONSUMPTION OF NON-FERROUS METALS

Detailed figures of consumption of non-ferrous metals in the United Kingdom during the second quarter of 1946 have been issued by the Directorate of Non-Ferrous Metals. Consumption of virgin metals was as follows (in tons):—

	First Quarter, 1946	Second Quarter, 1946
Zinc	50,653	51,548
Lead	55,426	48,013
Tin	5,421	6,449
Nickel	2,098	3,094
Cadmium	127	138
Antimony	1,490	1,274
Cobalt	149	244
Manganese metal	136	149

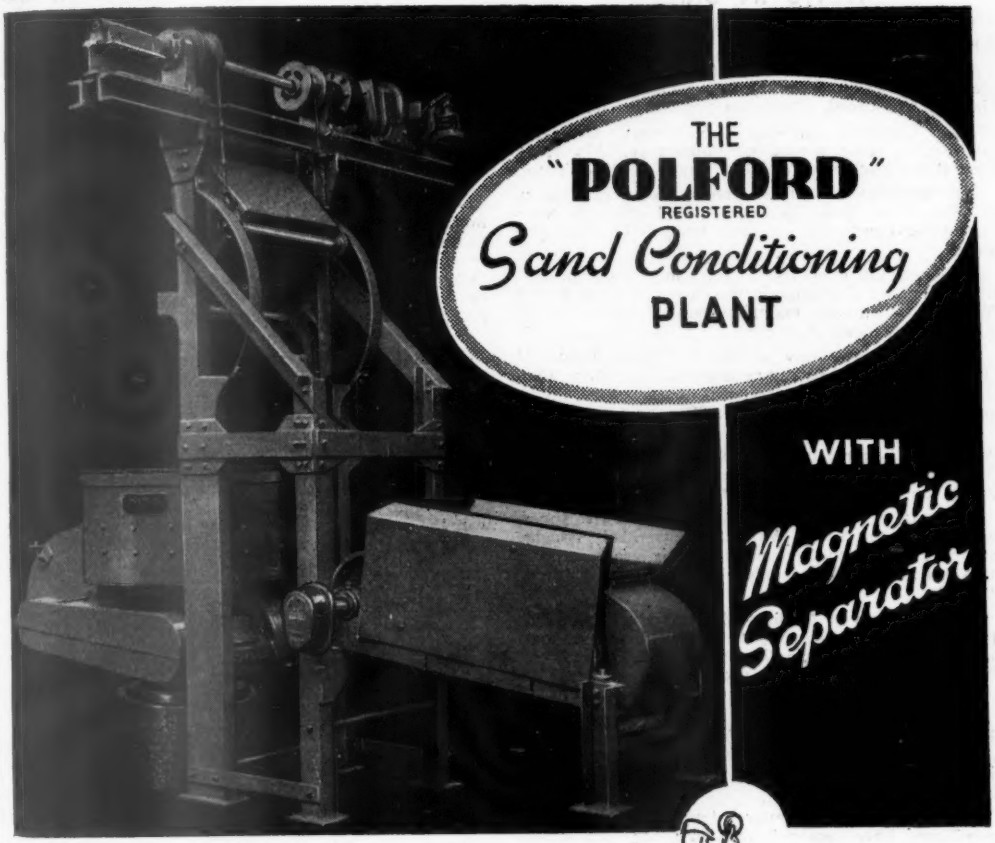
STEEL OUTPUT IN BRITISH ZONE

Steel production in the British zone of Germany in July was the highest monthly level since the occupation began. The improvement was due to increased allocations of coal and coke to the industry for the third quarter of the year. Shortage of labour is still restricting production.

The output of rolled products was 181,200 tons, an increase of 19,347 tons over the June figure, which was itself a record. The ingot steel output was 210,321 tons, and exceeded by 24,521 tons the previous highest level reached in March. The July production of pig-iron was substantially higher than in June and only slightly below the March record.

METAL INDUSTRIES, LIMITED, who raised the ex-German warship "Derfflinger" at Scapa Flow in 1939, are preparing to tow the upside-down wreck from Orkney to Faslane, their new shipbreaking port on the Gareloch. "Derfflinger" was one unit of the scuttled ex-German High Seas Fleet of the first world war. Outbreak of war in 1939 stopped the towing of the vessel to Rosyth, and it was armed for defence against aircraft.

PAT. No. 570997.



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NEWS IN BRIEF

THE BARTON LIMESTONE COMPANY, LIMITED, is being wound up voluntarily.

MEMBERS OF THE Manchester Association of Engineers are to visit the works of A. V. Roe & Company, Limited, Woodford, Ches., on September 18.

THE LINTHORPE-DINSDALE SMELTING COMPANY, LIMITED, is being wound up voluntarily. Mr. J. H. Tate, Royal Exchange, Middlesbrough, is the liquidator.

THE HOFFMANN MANUFACTURING COMPANY, LIMITED, of Chelmsford, have opened a branch office at Newcastle-upon-Tyne, the address being 217, Westgate Road.

DEALINGS ARE EXPECTED to start shortly on the Birmingham Stock Exchange in the shares of H. & J. Hill (Willenhall), Limited, manufacturers of annealing appliances, ironfounders, etc.

A 65-ACRE EXTENSION to the Hillington Industrial Estate at Glasgow has been announced. More than 150 factory units will be erected in the new area, giving employment to an additional 5,000 people.

THE WHOLE OF THE railway engineering department of Thomas Summerson & Sons, Limited, Albert Hill Foundry, Darlington, is to be transferred to a new factory on the Spennymoor Trading Estate.

SPEAKING AT SWANSEA recently, Sir Lewis Jones, secretary of the South Wales Siemens Steel Association, referred to the prospects of this year's exports of Welsh tinplates being only about one-third of those of 1938.

THE EXPANSION BY Nuffield Metal Products, Limited, at its factory at Washwood Heath, Birmingham, may mean employment of another 1,000 or 2,000 workers. The scheme is expected to take up to two years to complete.

NEW RESEARCH LABORATORIES were opened on August 23 at the works of Ashmore, Benson, Pease & Company, Limited, and the Power-Gas Corporation, Limited. The ceremony was performed by the Mayor of Stockton-on-Tees.

C. A. PARSONS & COMPANY, LIMITED, of Newcastle-upon-Tyne, have received an order for two steam turbo-generators and two steam condensing plants, valued at £473,000, from the State Electricity Commission of Victoria, Australia.

A PARTY OF British electrical engineering experts, headed by Sir George Nelson, chairman of the English Electric Company, Limited, have arrived in the Soviet Union. It is understood that they are prepared to discuss "substantial orders."

"THE WELDABILITY OF MALLEABLE CAST IRON" is the title of a lecture to be given by Mr. T. J. Palmer to the North London branch of the Institute of Welding at 7.30 p.m. on September 11. The meeting will be held at the Polytechnic, Regent Street, W.1.

THE RETURNS OF South Crofty, Limited, during 1945 did not come up to expectations, chiefly owing to a drop in the tonnage milled of approximately 3,500 tons, which yielded 586 tons of black tin—125 tons less than in 1944, says Mr. Harry Rich, chairman, in a statement accompanying the annual report. They hope that a reasonably long-term policy might be adopted by the Government which would enable their immediate mineral area to be thoroughly developed.

SPEAKING AT A Press conference following the publication of the July export figures, which were higher in that month than in any month since the end of the war, Mr. H. A. Marquand, Secretary of Overseas Trade, said that, unless industry could get the coal and steel it required to maintain the present standard of production, Britain's exports were likely to decrease. The shortage of steel, he said, had forced the Government to reduce the allocation for export—a very serious thing. Steel formed a very significant part of our exports, but supplies for export had been cut because imports had dropped considerably.

EDWARD LE BAS & COMPANY, LIMITED, iron, steel and metal merchants and exporters, of 14, Finsbury Circus, London, E.C.2, announce that the name of the company has been changed to I. S. & G. Merchants, Limited. The direction, policy and personnel remain unaltered, and the change has been necessitated by the confusion which has arisen owing to the similarity of the name with that of their associated company, Le Bas Tube Company, Limited. Following the dispersal of their productions during the war, the company state that they have now taken over works at Kent House Lane, Beckenham, Kent.

OBITUARY

MR. W. W. SKIDMORE-WESTWOOD, proprietor of Westwood & Wrights, Limited, gas engineers, ironfounders, etc., of Brierley Hill, Staffs, and Dudley, Worcs, has died at the age of 88.

MR. ROBERT WALLACE, principal of J. & R. Wallace, agricultural engineers and ironfounders, of Castle-Douglas, Scotland, died recently. He was responsible for many improvements to farm machinery, especially milking machines.

MR. EDGAR STOPFORD SAUNDERS, who retired in 1941 from the administrative staff of the London and Home Counties Joint Electricity Authority, has died at the age of 70. He was appointed chief assistant in the Electricity Supply Department of the Bradford Corporation, and, in 1901, he joined the sales department of the British Westinghouse Company. Three years later he became electrical engineer to Guest, Keen & Company, Limited. In 1908, Mr. Saunders was appointed general manager for the Indian Empire to Siemens Bros. & Company, Limited, and for seven years was engaged on the erection of colliery, hydro-electric, and steelworks plant. After a period in the sales department of J. Stone & Company, Limited, engineers and non-ferrous founders, etc., of Deptford, London, S.E.14, Mr. Saunders held a similar position in the cable department of the General Electric Company, Limited, until he joined the London and Home Counties Joint Electricity Authority in 1930.

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SLAG penetration of refractory materials normally accompanied by erosion, surface spalling, shrinkage, etc., is frequently responsible for the ultimate failure of refractories. To reduce the destructive effect of slag penetration, volume-stable, dense, low-porosity, low-permeability bricks, with the correct chemical composition, must be used. A characteristic of G.R. products is that they possess these necessary qualities and thus ensure minimum slag penetration. The services of G.R. engineers are available on request, to users, on the choice and application of refractories.

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Raw Material Markets

IRON AND STEEL

Production of all grades of pig-iron remains fairly constant and in the case of basic iron is ample for current needs. The freedom with which the Control is issuing licences for hematite, medium- and low-phosphorous and refined iron suggests that supplies of these grades are also adequate for current needs, but it is less easy to respond to the pressure for high-phosphorous iron for the light-castings trade. More iron is wanted for the production of housing components, but how to increase the supply is still an unsolved problem.

From the Board of Trade has come official confirmation of the fact that the shrinkage of imports of semi-finished steel is adversely affecting the operation of the re-rolling mills. The British steelworks are keeping the sheet mills reasonably well provided with bars, although the tonnages required have never been so heavy. But to maintain the output of sheet bars, has meant the curtailment of the supply of billets, of which many establishments are now in urgent need.

All the rolling mills have now formidable programmes and in the booking of further business the chief difficulty is to indicate even approximate delivery dates. Few, if any, of the plate mills can take on any more orders this year and the position at the sheet mills is even more congested. Re-rollers of bars and light sections might possibly take on more business for December delivery, but orders placed for heavy structural steel, railway and colliery material have reached formidable proportions.

NON-FERROUS METALS

Reports that an announcement regarding an increase in the price of tin is imminent continue to circulate, but so far the intentions of the authorities have not been made known. Supplies of tin are a little easier, but there is room for very much improvement in this direction.

To ensure compliance with the Control of Tin (No. 3) Order, 1941, certain formalities will be necessary in connection with tin metal which has to be transhipped in this country in bond when *en route* through the United Kingdom for destinations abroad. Importers should, where necessary, apply for further information either to the Directorate of Non-Ferrous Metals, 20, Albert Street, Rugby, or to the secretary of the London Metal Exchange, Whittington Avenue, E.C.3.

The Rhokana Corporation and Nchanga Consolidated Copper have formed a new company called the Rhodesia Copper Refineries, Limited, in order to finance the refinery extensions called for by the projected expansion of the production of Rhodesian copper. The authorised capital of the new company will be £2,500,000. The company proposes to purchase the Rhokana Corporation's existing copper refinery. This plant will be duplicated immediately, and it is estimated that this extension will allow of the refining of the Rhokana and Nchanga total production until 1951.

A further extension may be arranged in order to cover the increase of production from the Nchanga mine which will become operative about 1952.

Lead supplies are far from satisfactory and many reports are coming to hand of consumers' difficulties. Shortage of lead is stated to be retarding production of a number of important manufactures.

PERSONAL

MR. J. H. DUNBAR, a director of Lancashire Dynamo & Crypto, Limited, has been appointed assistant managing director of the company.

MR. W. S. SCOTT, works superintendent, and MR. H. G. GRADWELL, sales manager, have been appointed special directors of the Darlington Forge, Limited.

MR. JOHN MONAGHAN, of Wednesbury, a metallurgist on the staff of Stewarts and Lloyds, Limited, has gained first-class honours B.Sc., Metallurgy, the only distinction of its kind to be awarded this year.

MR. N. ISAACS, on relinquishing his appointment as Director for Ferro-alloys and Adviser on Wolfram in the Iron and Steel Control of the Ministry of Supply, has joined the board of Derby & Company, Limited, precious and non-ferrous metal dealers, etc., of Finsbury Square, London, E.C.2.

MR. ARTHUR WHITELEY, managing director of the Glanmor Foundry Company, Limited, and its associated company, Thomas & Clement, Limited, iron-founders, manufacturers of tinplate cleaning plant, etc., both of Llanelly, has accepted the Government's invitation to become controller of foundries in the British zone in Germany.

Wills

DAVIES, A. E., London representative of William Hunt & Sons, The Brades, Limited, steel and edge tool manufacturers, of Oldbury, Worcs. ... £4,307

KNIGHT, W. E., a director of Darwins, Limited, and Andrews Toledo, Limited, of Sheffield, and managing director of Metal Mouldings, Limited, of Willesden, London, N.W.10 ... ... £16,564

THE BRITISH STEEL FOUNDERS' ASSOCIATION are holding their first technical conference in Sheffield from October 3 to 5.

"COPPER DATA," "Bearing Bronzes," "German Copper and Brass Welding Practice," "Lead Bronze Bearings," and "Classification of Copper and Copper Alloys," have been reprinted and will be supplied free of charge by the Copper Development Association, Kendals Hall, Radlett, Herts., to anyone who gives evidence of genuine interest. Those wishing to receive future publications as they become available should notify the Association accordingly.